United States Patent [19]

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[54] **AMMUNITION TRACER SYSTEM**

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[52] **U.S. Cl.** ..... **89/1 R**, 102/87

[51] **Int. Cl.** **F41f 5/00**

[58] **Field of Search** ..... 102/87, 90, 70.2; 244/313; 89/41 L; 343/18 B, 18 C, 18 E

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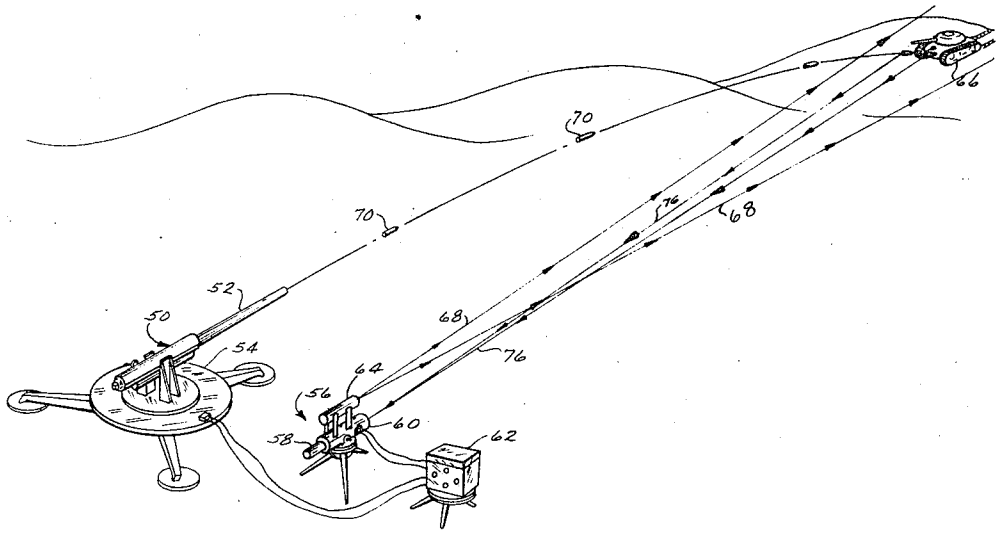
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[57] **ABSTRACT**

An ammunition tracer system having a retro-reflective trailing edge on all projectiles and a laser illuminator bore-sighted with the weapon sighting and viewing equipment. At the sighted target, the reflective trailing edge of the projectile reflects the laser rendering the projectile visible in the viewing equipment.

6 Claims, 6 Drawing Figures



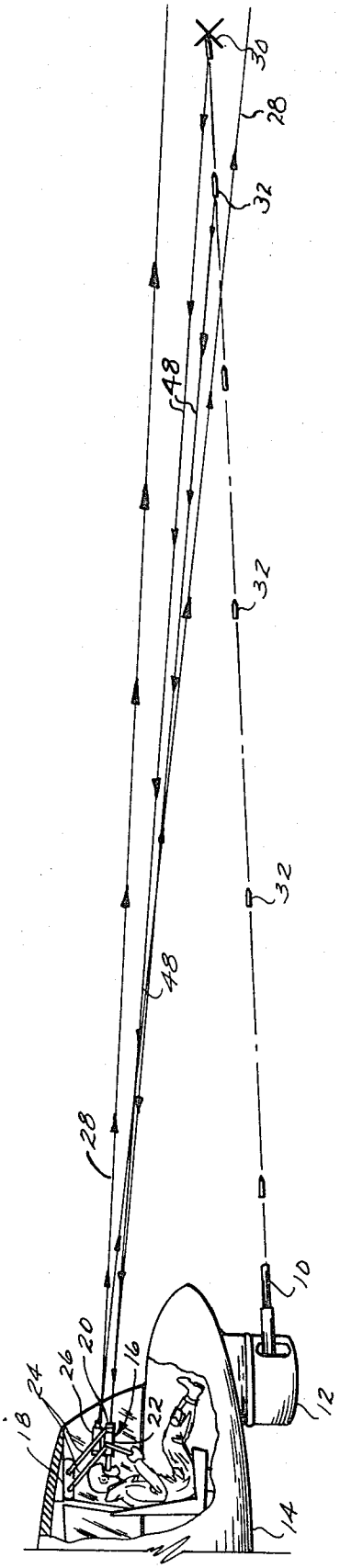


FIG. 1

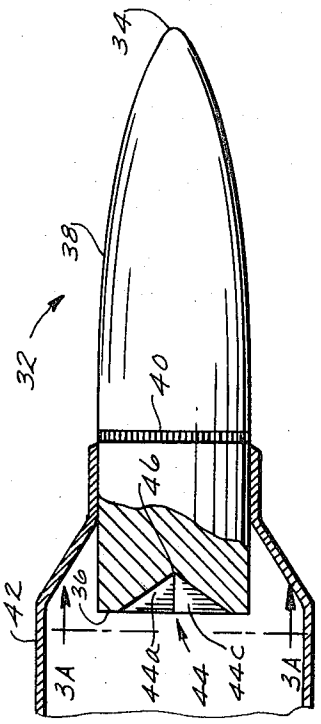


FIG. 3B

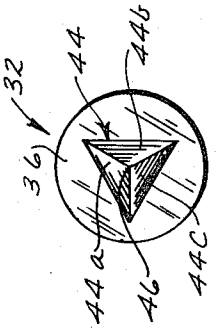


FIG. 3A

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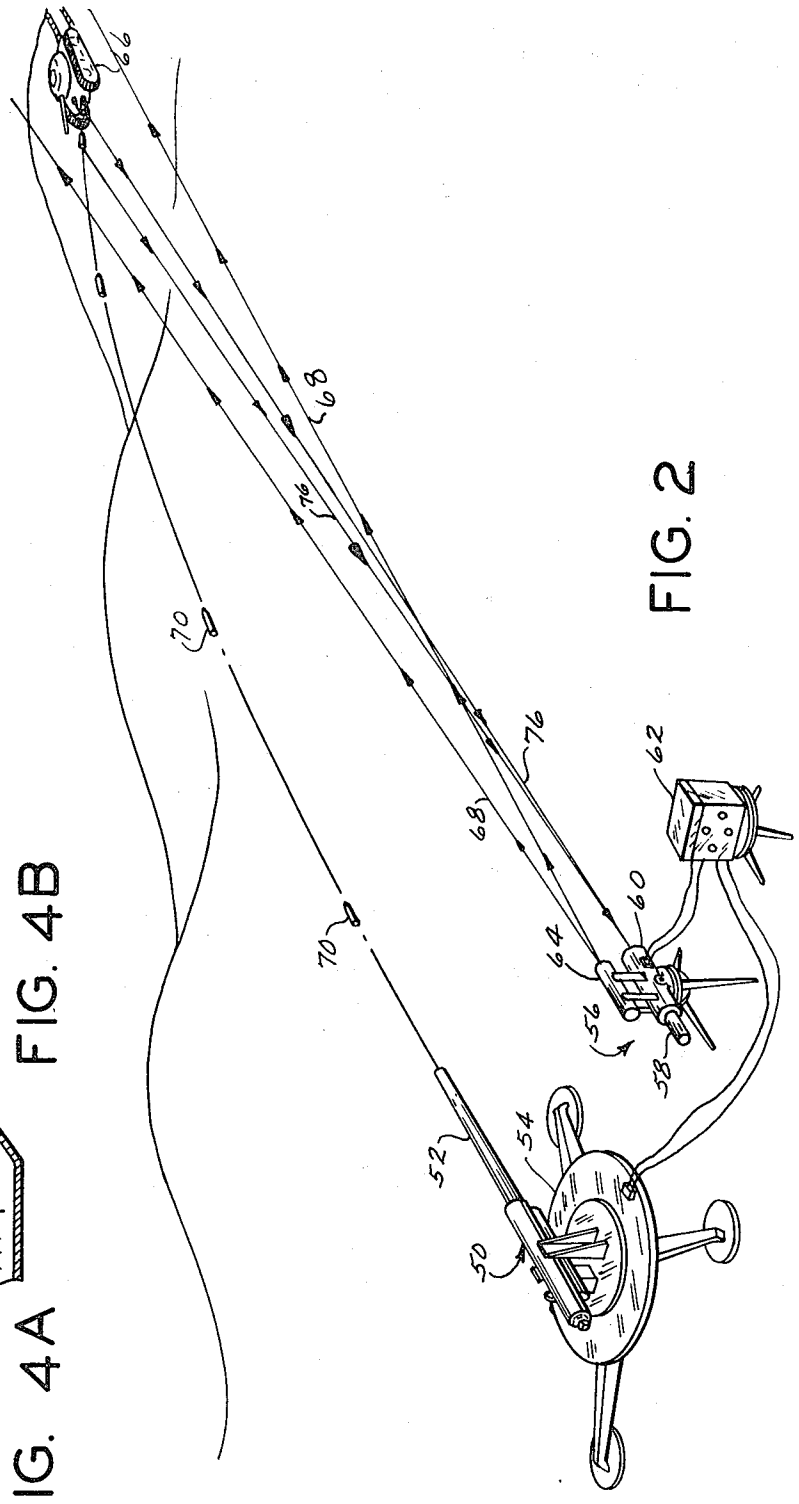


FIG. 2

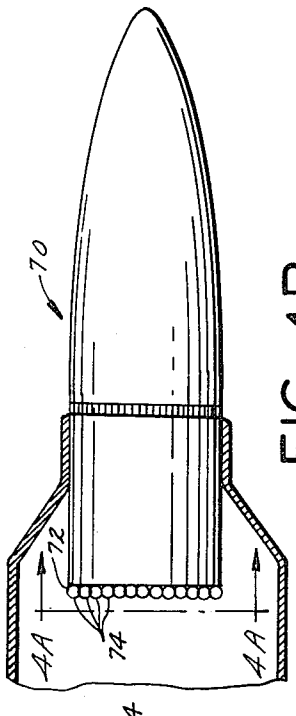


FIG. 4B

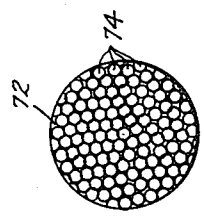


FIG. 4A

AMMUNITION TRACER SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to a weapons system, and more particularly to an ammunition tracer system and projectile for observing the point of impact of a projectile fired from a weapon.

Present tracer ammunition employ a pocket of phosporous material in the interior rearward end of the projectile which is caused to burn and illuminate over a portion of the trajectory of the projectile. While such tracers have generally served the purpose of illuminating to indicate trajectory and point of impact, they have all suffered to a greater or lesser extent from one or more serious disadvantages. For example, the effective range (i.e., 3,000 meters) of modern projectiles is such that the phosporous material may be totally consumed before the projectile reaches the target. This obviously limits the usefullness of such tracers to targets at relatively close range.

In addition, the traced projectile (normally every sixth projectile) may exhibit slightly different flight dynamics than untraced projectiles due to the change in configuration of the traced projectile necessitated by the inclusion therein of the illuminating phosporous material. Thus, traced projectiles generally have a greater overall length than untraced projectiles of the same caliber, and have a chamber extending forwardly from their trailing edge containing the phosporous material.

Further, present traced ammunition seriously interferes with low light level night viewing equipment since this equipment is subject to saturation by the traced light of the projectile at close range. In addition, present traced ammunition poses logistics problems in that two types of ammunition must be handled and the traced ammunition must be interspersed with the hard ammunition in the loading process. Conventional traced ammunition is also relatively expensive and subject to malfunction.

SUMMARY OF THE INVENTION

Accordingly, among the several objects of the present invention is the provision of an ammunition tracer system and projectile whereby every projectile is of the tracer type and is visible to the full range of the weapon; the provision of such a system and projectile wherein trajectory variations of the traced ammunition are eliminated; the provision of a tracer system and projectile of the class described which does not interfere with the operation of night viewing equipment, which eliminates multiple ammunition logistics problems, and which is characterized by simplicity of construction, low cost and ease of operation and use.

In general, an ammunition tracer system constructed in accordance with the present invention comprises a weapon for firing a projectile and a sighting station associated with the weapon and operative therewith for viewing a target area. A source of coherent light is operatively connected with the weapon for projecting a beam of coherent light at the target. An ammunition projectile is provided for the weapon, the projectile having a light reflective trailing edge for reflecting, in the target area, the beam of coherent light. Non-coherent light may also be used.

An ammunition tracer constructed in accordance with the present invention comprises a projectile of

elongate, generally aerodynamically streamlined configuration having a leading edge, a trailing edge and a body portion. The projectile is provided with light reflecting means on its trailing edge for reflecting a beam of light projected thereagainst for rendering the same visible. Other objects and features will be in part apparent and in part pointed out hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective of the ammunition tracer system of this invention as applicable in a vehicle such as a helicopter;

FIG. 2 is a perspective of the invention similar to FIG. 1 for an artillery piece;

FIGS. 3A and 3B are end and side elevation views, respectively, of one embodiment of the projectile of this invention; and

FIGS. 4A and 4B are end and side elevation views, respectively, of another embodiment of the present projectile.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, and particularly to FIG. 1, the present ammunition tracer system is shown to comprise a weapon, such as a rapid-fire machine gun 10, housed in a turret 12 on a helicopter 14 for movement of the gun in both azimuth and elevation. The gun 10 is provided with a sighting station 16 and a fire control system 18 for directing the fire of the gun. The sighting station 16 includes an optical system 20 and low light level viewing equipment 22 interconnected to the fire control system 18 via links 24, the low light level viewing equipment serving to amplify existing and reflected light, as will be set forth more fully hereinafter. As the gunner scans a potential target area through viewing equipment 22 and optical system 20, the gun 10 is caused to move in azimuth and elevation simultaneously therewith for firing upon command of the gunner. Optical or electronic range finding equipment may also be provided depending upon the sophistication of the system.

In normal operation of the system, every sixth projectile fired from gun 10 is a tracer to visually indicate to the gunner trajectory and point of impact of the fired projectiles. As set forth above, however, conventional prior art tracers suffer from several shortcomings which seriously affect their usefullness.

The present tracer system incorporates a source of coherent light, such as a laser 26, bore-sighted with the sighting station 16 and operatively connected therewith for projecting a continuous, pulsed, or modulated beam of coherent light, indicated by arrows 28, at a target 30 being viewed by the gunner in the sighting station. As will be set forth hereinafter, each projectile 32 fired from weapon 10 will be visible at the target area in the viewing equipment 16.

As illustrated in FIGS. 3A and 3B, the projectile 32 of this invention is of generally aerodynamically streamlined configuration having a leading edge 34, a trailing edge 36 and a body portion 38, the latter having a knurled ring 40 circumscribing its periphery near its center. A casing 42, containing gun powder or the like (not shown), telescopically receives the rearward end

of the projectile and is fixed thereto at the knurl line **40.** As with conventional ammunition, the projectile **32** is propelled from the casing **42** when the powder charge therein is ignited.

A light reflective surface **44** is provided on the trailing edge **36** of projectile **32** for reflecting the beam of light **28** projected from laser, **26,** as indicated by arrows **48.** In the FIG. **3** embodiment, this reflective surface comprises a concave 90 degree corner reflector having three mutually perpendicular planar faces **44***a*, *b* and *c* intersecting at an apex **46.** While the depth of the reflector **44** may vary, a depth of 0.2652 times the outer diameter of the projectile is preferred and may be provided by a simple one-step punching operation.

The system shown in FIG. **2** is similar to that shown in FIG. **1** with the exception that the invention is used with an artillery piece **50** rather than machine gun **10.** As illustrated, the piece **50** comprises a gun **52** gimballed on a platform **54** for movement in azimuth and elevation. A sighting station **56** includes an optical system **58** and low light level viewing equipment **60.** The sighting station **56** is interconnected to a fire control system **62** which controls the movement and firing of piece **50.** A laser **64** is carried on the sighting station and is bore-sighted therewith for illuminating a target, such as tank **66,** as indicated by arrows **68.**

A projectile **70** for piece **50** is illustrated in FIGS. **4**A and 4B, the projectile being substantially identical to the FIG. **3** projectile **32** with the exception of its light reflective trailing edge **72.** As illustrated, the reflective surface is formed of a plurality of small glass or plastic beads **74** bonded to the trailing edge of projectile **70** for reflecting the beam of light projected from laser **64,** as indicated by arrows **76.**

In operation of either the FIG. **1** or **2** system with either the FIG. **3** or **4** projectile, each projectile, in all calibers from 5.56 mm. machine gun through 40 mm. cannon and 175 mm. artillery, is provided with an optical retro-reflective trailing edge. This may be accomplished, for example, by the FIG. **3** corner reflector, the FIG. **4** glass beads, or by a single glass bead or a matrix of concave reflectors. Thus, each projectile fired will be a tracer and all will have identical flight characteristics. When a projectile is fired from its weapon, it travels its normal trajectory to the target which may include compensation for wind, velocity of the weapon and/or target, range, etc. When the projectile enters the target area, the beam of projected light from the laser is reflected by the reflective trailing surface of the projectile back to the low light level night viewing equipment and is visible therein. Thus, each projectile will be visible in the target area.

Specifically, as regards the corner reflector of FIG. **3,** for example, it is characteristic of this type of reflector that it returns incident light on a path parallel to its incidence, for all incidence angles up to 45 degrees. The low light level sighting device is boresighted to a small pulsed laser whose output wavelength is within the sensitivity band of the viewing device. When the sight is on the target, laser pulses will illuminate the target area. If the weapon's characteristic dispersion is ±5 mils, for example, and it is desirable to see all of the projectiles, then the dispersion of the laser beam must also be ±5 mils. In this regard it should be noted that the energy returned to the receiver decreases by the fourth power of the laser dispersion angle.

The projectiles will only be visible to the gunner when they are within the cone of the laser dispersion angle. Thus, at pointblank or flat trajectory ranges they would be visible practically all the way to the target. At long or maximum range, however, they would be visible only in the vicinity of the target assuming that the projectile angle does not exceed 45 degrees at maximum range.

The following example will illustrate the principal of operation of the present invention using the following assumptions.

Light Source — pulsed laser, = 6,000 – 7,000A, peak power 10^9 watts. PRF 30/second.

Mirror Reflectance — 60%.

Atmospheric Absorption — 10% /kilometer.

Transmittance of Laser Optics — 90%.

Divergence Angle of Laser Optics — ±5 mils.

The energy density at the receiver, using the above criteria for the worst case (maximum range for each weapon) is shown in the following table:

Caliber	Max. Range	Watts/cm² Received
5.56 mm.	500 meters	7.1×10^{-4}
7.62 mm.	1000 meters	7.5×10^{-5}
0.50 cal.	2000 meters	1.0×10^{-5}
20 mm.	3000 meters	4.2×10^{-6}
30 mm.	2500 meters	2.1×10^{-5}

If the area of the receiver optics is 75 cm.², with a transmission coefficient of 0.67, the peak incident energy from each projectile is 50 times the received energy density. In the worst example, (20 mm. at 3,000 meters), this would put 2.1×10^{-4} watts on the photocathode of the night vision device at each image point and the projectiles would be clearly visible therein. For all other cases analyzed, the energy on the photocathode will be greater.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results obtained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained herein shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. An ammunition tracer system comprising a weapon for firing a projectile, a sighting station associated with said weapon and operative therewith for viewing a target area for the weapon, a source of coherent light operatively connected with said weapon for projecting a beam of coherent light at the target, and an ammunition projectile for said weapon, said projectile having a light reflective trailing edge for reflecting, in the target area, said beam of coherent light.

2. A tracer system as set forth in claim **1** wherein said source of coherent light is a laser.

3. A tracer system as set forth in claim **1** wherein said sighting station further comprises low light level viewing equipment for amplifying the reflected light to render the same visible.

4. A tracer system as set forth in claim **3** wherein said source of coherent light is a laser.

5. A tracer system as set forth in claim **1** wherein said light reflecting trailing edge comprises a concave corner reflector formed in said projectile trailing edge.

6. A tracer system as set forth in claim **1** wherein said light reflecting trailing edge comprises a plurality of glass beads bonded to said projectile trailing edge.

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